

FINAL MEMORANDUM

1. ADMINISTRATIVE:

Award Recipient: North Carolina State University

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Title: Global Change Monitoring

Award No.: G14AP00078

Time Period: 9/15/14-9/14/16

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2. PUBLIC SUMMARY:

Detecting change in ecosystems requires observations of living and non-living components over time. Many different organizations make observations that are relevant to understanding global change processes, but the data are often not easily discoverable by other interested scientists and managers. This project pulls into a centralized location information about many of these observational networks. This phase of the project enhanced a pilot publicly available web-based portal that provides a means to discover, search, and connect to many types of environmental and biological data collected in the southeastern United States that are relevant to characterizing potential effects of climate and land use change on land, water, and wildlife. The Global Change Monitoring Portal (GCMP) consolidates information about data resources from research and monitoring done by federal, state, tribal, local, and non-governmental organizations; it provides opportunities for discovery by users who are land managers, scientists, tribal and other leaders, decision makers, and citizens. Data resources can be visualized and searched by categories of measurements made and/or by specific geographic criteria such as state, ecoregion, hydrologic unit, and Landscape Conservation Cooperative. The GCMP provides a mechanism to increase the usefulness of important data collection efforts by a broad range of organizations by making the data more accessible to users.

3. TECHNICAL SUMMARY:

The goal of the project is to provide a centralized information source that allows users to discover, search for, and connect to data resources relevant to various land-management and science questions, especially related to changes in climate and land use. The sources of data include federal, state, tribal, local, and non-governmental. The metadata portal will provide background to support assessments of monitoring programs in the Southeast. The audience for the Global Change Monitoring Portal is primarily land managers and scientists, but the information is publicly available. This is a public service project that utilizes the results of other research and monitoring programs and serves as portal to information provided by these other programs.

The primary task was to compile, inventory, and map geographically, sources (federal, state, local and non-governmental) of atmospheric, terrestrial, water quality and quantity information and analysis capacity in the region to address climate and land use change issues. This was accomplished by development of a database of metadata for a range of monitoring programs/observational networks

that collect or have collected data in the southeastern US, including the Caribbean. The metadata includes details of observations made, purpose of sampling, sponsoring organization, period of record, classification of measurements made, program contact, and means of data access. Details of locations where observations are made are included when made available and are represented by point locations with a proximity descriptor; period of record is also included.

Results from this work provide the region's scientists and decision makers with accurate and comprehensive information about monitoring networks that can be used to assess the potential effects of climate and land use change in the southeastern United States. The centralized inventory of monitoring programs will also contribute to a region-wide assessment of monitoring by a range of partners.

4. PURPOSE AND OBJECTIVES:

The purpose of the project was to provide a centralized, comprehensive catalog of information about monitoring networks associated with aquatic and terrestrial ecosystems that can be used to assess the potential effects of climate and land use change in the southeastern United States.

This project was developed to address a problem that emerged as a common issue among Southeast Climate Science Center partners as its science agenda was developed. The problem was that despite a lot of climate and ecosystem data being collected, it was difficult to know what observations are being made by what organizations and how to access the data. The intended solution was to bring information about the broad range of measurements made in ecosystems across the Southeast by many organizations into a centralized location. The goal was to make monitoring data more easily discoverable by interested scientists, land managers and decision makers.

The tasks were originally proposed as

- a) Compile, inventory, and map geographically, sources (federal, state, local and non-governmental) of atmospheric, terrestrial, water quality and quantity information and analysis capacity in the region to address climate issues;
- b) Characterize the sources of information in terms of longevity and "depth", consistency over time, and types and quality of information;
- c) Assess other attributes of the information sources to be identified;
- d) Assess currently available information for use in tracking regional trends, or running scenarios of interest to federal, state and local resource managers;
- e) Identify key information gaps of concern to federal, state and local resource managers.

This overall objective did not change and the development of a metadatabase and web portal was accomplished. Characterization of data consistency and data quality was not feasible to incorporate in a consistent way for all the programs included in the inventory, but we incorporated program details, means to access their data, and a program contact. These should guide a resource manager or other user to be able to evaluate the suitability of data resources for his/her purposes.

5. ORGANIZATION AND APPROACH:

The following graphic summarizes the general approach used to develop the Global Change Monitoring Portal. Effort in this phase centered primarily on the first and last two steps in the approach.

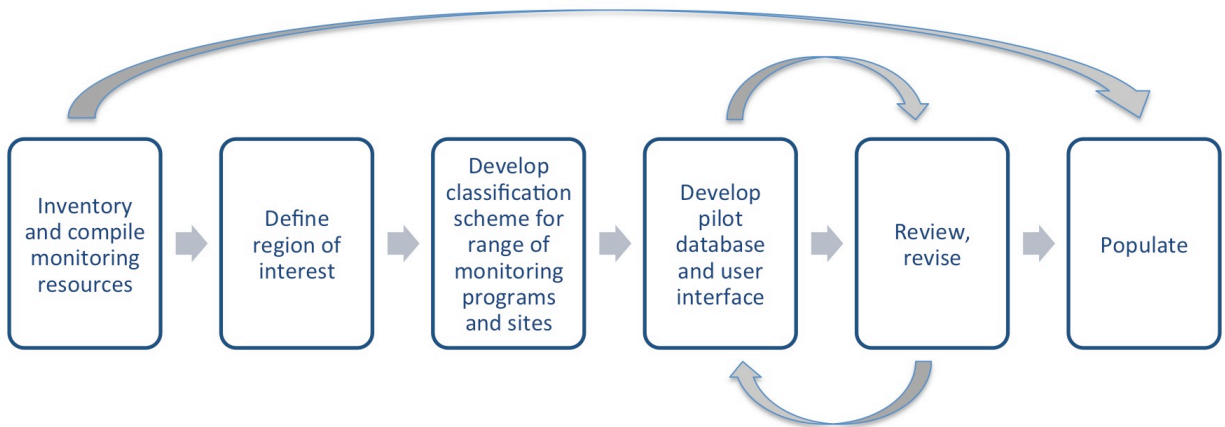


Figure 1. Development approach for Global Change Monitoring Portal.

6. PROJECT RESULTS:

Inventory and compile monitoring resources. During this phase, we continued to utilize previous efforts that were undertaken to compile information about monitoring programs by us and other partners, as well as existing metadata portals and publicly available data warehouses, to develop a list of observational networks for which to derive metadata for our project. Examples of these groups and portals are National Monitoring Network Federal Monitoring Inventory, Ecosystems Interagency Workgroup, Albemarle-Pamlico National Estuary Partnership National Monitoring Network Pilot, NAWQA National Data Aggregation, SE Coastal Water Quality Monitoring Metadata Portal, NC Climate Retrieval and Observations Network of the Southeast Database, Water-CAT Florida Water Resource Monitoring Catalog, Data.gov, and US Fish and Wildlife Service Southeast Region Inventory and Monitoring PRIMR. We focused on federal, state, local, tribal, and non-governmental networks of atmospheric, terrestrial, and water quality and quantity observations relevant to issues of global change. Additional programs for potential inclusion were also compiled from web-based and other research, and recommendations from agency contacts and colleagues (a snowball approach).

Because of the large amount of relevant data from disparate sources and varying accessibility, acquisition of some of the metadata elements of observational networks, and especially associated site information, required significant time and effort. Although some monitoring program representatives provided information about their program(s) in the standard template requested, in general metadata was gathered from many different sources of information, such as online descriptions, data warehouses, technical reports, monitoring SOPs, etc.

Define region of interest. The geographic scope of this effort was initially proposed to include the states of North Carolina, Tennessee, Mississippi, Alabama, Georgia, and Florida and the Commonwealth of Puerto Rico. The geographic scope of the Global Change Monitoring Portal was later

expanded to include the regions of five Landscape Conservation Cooperatives (LCCs) – Caribbean, Peninsular Florida, South Atlantic, Gulf Coast Prairie, and Gulf Coastal Plains and Ozarks – and part of a sixth – Appalachian, as shown below. This allows the database to be relevant to a greater number of LCCs and their partners. Many monitoring programs are national or regional in scope or operate within non-geopolitical geographic boundaries such as the Gulf of Mexico, such that areas where observations are made often cross state lines. The GCMP region encompasses all of 11 states/territories – Arkansas, Louisiana, North Carolina, Tennessee, Mississippi, Alabama, Georgia, Florida, South Carolina, US Virgin Islands, and the Commonwealth of Puerto Rico – and portions of seven others – Texas, Oklahoma, Missouri, Virginia, Kentucky, Illinois, and Kansas. If a monitoring program made observations at sites outside the GCMP region of interest, only those sites that intersected the GCMP region were included in the database. In January 2016, updated footprints developed by the LCCs were incorporated into the GCMP region for determining sites to include in the database.

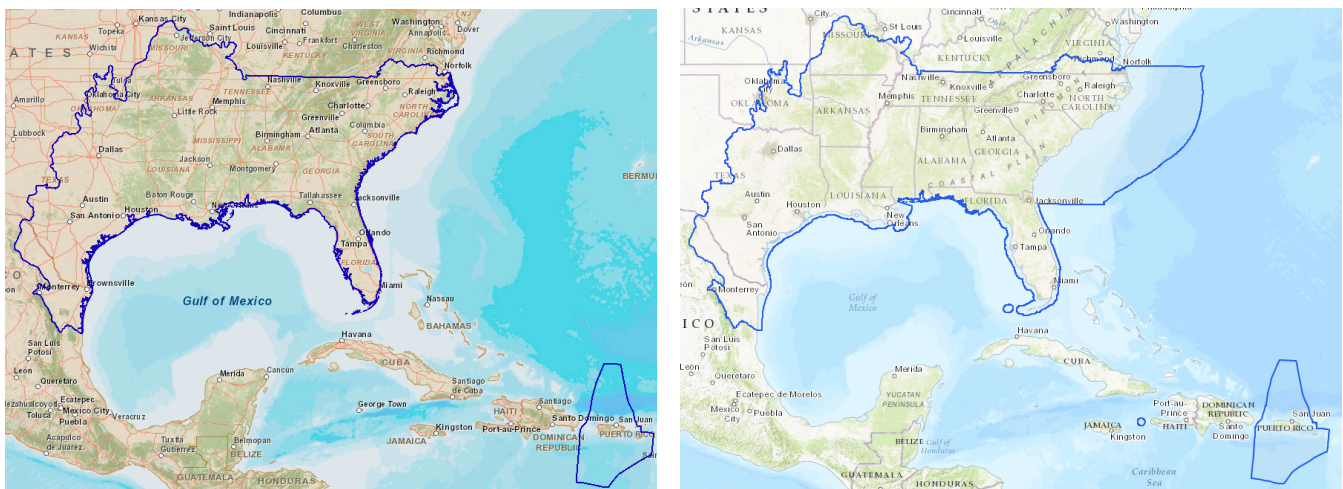


Figure 2. Original and revised geographic region of the Global Change Monitoring Portal.

Develop classification scheme for monitoring programs and sites. We developed a template for common metadata to describe general aspects of monitoring programs/observational networks. Metadata describes details such as purpose of sampling, geographic area sampled, name and type of sponsor, begin and end dates, and URLs for program description and data access. As part of the metadata template, we developed a general classification scheme for categorizing the observations made by monitoring programs, with the goal to develop a scheme that is broad enough to describe types of observational data collected by disparate networks, but at a level of detail to allow users from different disciplines to find programs and data relevant for their purpose. The scheme classifies an observation according to the following categories:

- (a) Media Type – the abiotic component of ecosystem in which a measurement is made,
- (b) Measurement Type – what category of ecosystem property is measured, and
- (c) Types of Parameters measured within those Measurement Types. Fairly broad categories are used, with definitions and examples provided to guide the user. Additional examples of types of parameters in parameter categories were added as unique programs were investigated.

The classification scheme was developed by drawing upon elements of classifications used by organizations such as EPA's STORET, USGS's NWIS, ITIS, as well as input from subject experts at NC State University.

Table 1. Measurement classification scheme for Global Change Monitoring Portal.

Measurement Category				
Media Type	Measurement Type	Biological Parameter Type	Chemical Parameter Type	Physical Parameter Type
Air	Biological	Ecosystem	Metals	Habitat
Land	Chemical	Fauna	Nutrients	Hydrologic
Water	Physical	Flora	Organic	Land cover
		Other Biological	Other Chemical	Meteorological
				Soil/Sediment
				Surface elevation
				Other Physical

One of the features of the metadatabase and portal is to allow a user to connect to programs and data based on the locations of measurement sites, so we incorporated georeferenced detail for the locations where measurements are made, when available. XY coordinates were categorized based on how close the coordinates are to the actual sampling location, according to the following table. These descriptors have the added benefit of allowing site location information to be included with the specificity preferred by a program, such that proprietary or sensitive site locations can be provided in a more generalized way, while still allowing a user to determine the general area in which observations are made by a program.

Table 2. Descriptor for how close the geographical coordinates are to the actual sampling location.

Exact – Exact sampling location
Approximate – Approximate sampling location
Offset – Offset to exact sampling location
Start – Beginning point of a linear sampling location
Boundary – One of a set of points used to describe the boundary of a polygon sampling location
Center – Center of polygon containing sampling location(s)
Admin – Administrative center of site or facility containing sampling location
Other – Coordinates represent a scenario not listed.
Unknown – Relationship between the coordinates given and the sampling location is unknown.
Not reported – Information is not reported regarding the relationship between the coordinates given and the sampling location.

The site locations are then assigned to specific geographic criteria by the mapping software; locations are assigned to the following geographic categories: State/Territory, Landscape Conservation Cooperative, Level III Ecoregion, and 8-digit Hydrologic Unit. These geographic criteria, in addition to the measurement categories, form the basis for search criteria. In cases where geographic coordinate information about measurement location was not known at all, measurement locations were assigned based on the states in which a monitoring program operates; coordinates representing the geographic centroid of each state were used for each state in which a program was known to make measurements. This will allow a user to locate metadata for those programs with a search on geographic criteria State.

Develop database and user interface. In the first phase of the project, we worked with a development team of USGS staff at the Fort Collins Science Center to determine the best platform for the metadatabase. After beginning preliminary design using the ScienceBase infrastructure, we moved to development using third party software and tools, primarily open source software, to allow more flexibility in the design. These include: PostgreSQL Relational Database, Apache/Tomcat Web/Application Server, Grails Web Development Framework, ESRI ArcGIS API for Javascript, and ESRI ArcGIS Server. The GCMP is hosted at USGS Core Science Application Hosting Center. Input to developers for design of the web interface for display and search of the metadatabase was accomplished by reviewing and evaluating existing data portals and websites to identify features and capabilities for our application. Some of those evaluated include: <https://my.usgs.gov/lfg/main/index>, <http://www.centralvalleymonitoring.org/map>, <http://mercnet.briloon.org/search>, <http://ecosystems.usgs.gov/maris/index.jsp>, <http://water-cat.usf.edu/>, <https://my.usgs.gov/crcwc/>. The Southeast Coastal Water Quality Monitoring Metadata Portal, <http://www.gcrc.uga.edu/wqmeta/>, and the research group at the University of Georgia who developed that project for National Park Service were especially useful in consulting on aspects of our database and portal. In the second phase of the project, we continued to improve features of the database, including mapping and display functions of the web portal interface and data download functionality, and to add metadata for additional monitoring programs and sites.

The Global Change Monitoring Portal is deployed at <https://my.usgs.gov/gcmp>, which can be reached also from a landing page on the SE CSC website, <https://globalchange.ncsu.edu/secsc/resources/southeast-global-change-monitoring-portal/>.

The web application providing the user interface is organized to provide access to all the functions of the GCMP from a main navigation ribbon. The primary functions found in each navigation section are described below.

Home page provides: General information and orientation to Global Change Monitoring Portal, including information and contact for updating or adding program metadata. From the home page the user can navigate to desired areas of tool, including a display map that links directly to the Main Map section of the application.

Browse Programs page allows a user to: view and explore partial metadata for all monitoring programs in GCMP; tailor the display by sorting on preferred column; search by text string to quickly reach a Program entry. Clicking on a Program name opens the display of full metadata for that program on its Program Page.

Main Map page: Functionality allows a user to visualize GCMP region of interest using various ESRI basemaps; view other geographic boundary layers; do some data discovery based on footprint of monitoring program(s), monitoring locations, and type of media sampled. On the main map display, clicking on a monitoring location on the map (or multiple ones at some scales) opens an information box that gives summary information for the point, such as which Ecoregion, LCC, and HUC8 the site location falls into, the Site Code and Program and direct links to the Site Page and Program Page. Figure 3 shows a graphic representation of the Main Map page, as well as some of the features described.

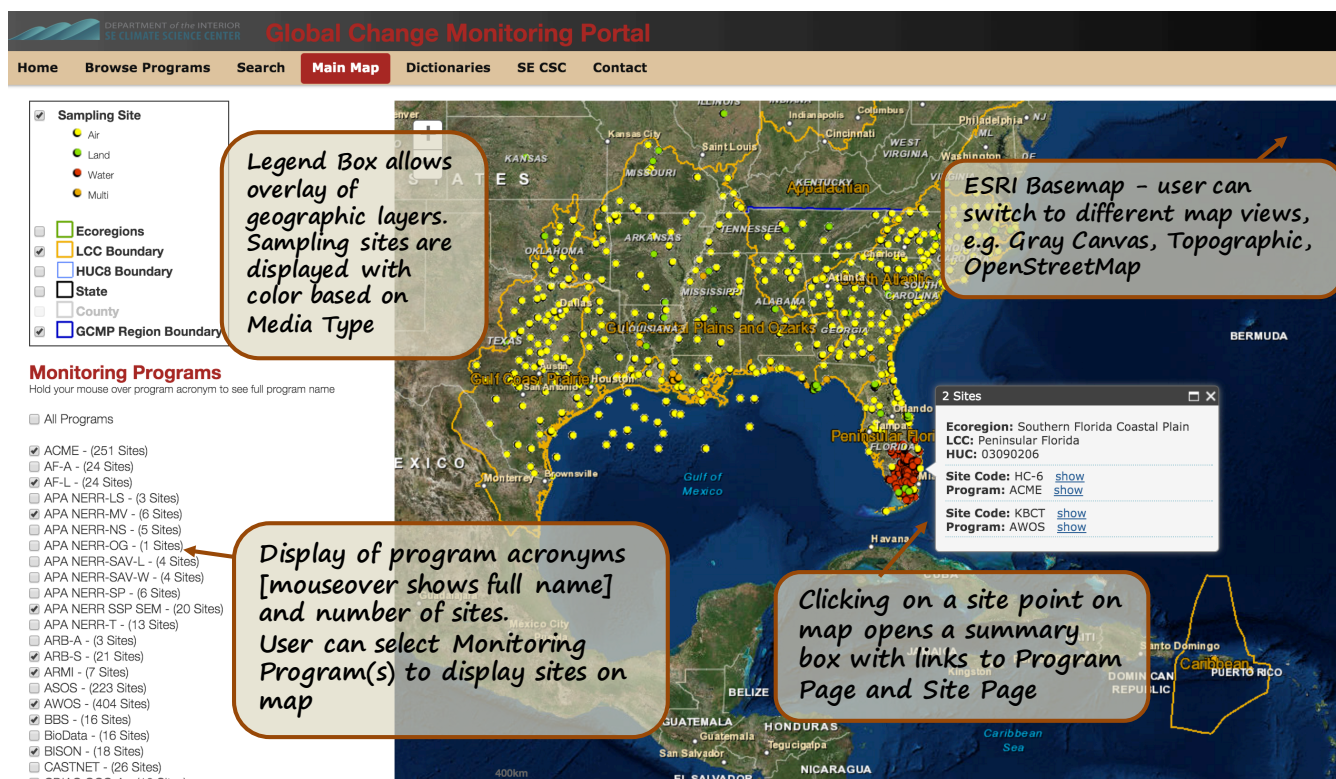


Figure 3. Display of Main Map landing page of GCMP, with some features highlighted.

Dictionaries menu includes: 1) Dictionary of Terms, containing additional information about some of the terms used in the GCMP, especially the definition of and types of measurements that fall within measurement classification categories; 2) Acronyms, a reference table of assigned acronyms for monitoring programs; and 3) HUCs, a sortable table correlating Names and 8-digit Codes assigned to Hydrologic Units.

SE CSC navigation button links directly to the Southeast Climate Science Center website. Contact page provides more detailed contact information for Cari Furiness, to connect about adding or changing information to the GCMP, as well as for the SE CSC.

Search page: This landing page provides the primary functions to allow a user to identify data resources of relevance to his/her specific interests. Users can: formulate searches for specific monitoring programs and/or monitoring sites by single or multiple categories; filter by Geography or by Measurements individually or combined; filter Measurements at the level of Media Type and/or at the level of Parameter Type; view Search Programs results on-screen along with criteria searched; view Search Sites results on-screen along with criteria searched and map display of sites selected; download site search results as a csv or Excel file. Figure 4 shows a display of Search page of GCMP, with some features of search criteria and example search results highlighted.

User can initially choose to Search Programs or also to Search Sites (requires more time). Default is Search Programs

Search Page allows user to search for programs and/or sites based on Geography criteria and/or Measurement criteria, and display results

Search Help box stays open to give user guidance for formulating search

User can clear individual search entries or entire form

Search results display below Search box, so search criteria remain visible

Results Total

User can toggle between display of Programs and of Sites matching search criteria. Clicking Sites tab will initiate Search Sites if Search Programs was initially chosen above.

Program	Sampling Purpose	Sponsoring Organization	Geographic Parameters	Measurement Parameters	Sampling Frequency	Data Span - Start	Data Span - End	Area Sampled	Sites in GCMP	
National Wetland Condition Assessment - Biological (NWCA-B)	Report on the ecological condition of wetlands nationally	USEPA			Periodic	2011	2011	Continuous US and Alaska	16	
USGS Amphibian Research and Monitoring Initiative (ARMI)	Assess scope and causes of amphibian declines Support effective management actions	US Geological Survey			Various	2000	Present	US	7	
Georgia DNR Coastal Resources Division Shellfish Water Quality (GCRD SWQ)	Monitor water quality of shellfish harvest areas Report on public health	Georgia Department of Natural Resources	Water	Biological	Other Biological	Bi-monthly	2000	Present	Georgia coast	88

Figure 4. Display of Search page of GCMP, with some features highlighted.

In the first phase, revisions to the pilot database and web portal were made in response to review comments about targeted aspects of the design and functions review solicited from representatives from the initial set of monitoring programs as well as LCC leaders, SE CSC staff, and other colleagues. In the second phase, development and testing to improve display and search of information by measurement-specific and geographic criteria continued as we worked with additional program and site metadata. In March 2016, we developed a tutorial describing the features of the GCMP (https://globalchange.ncsu.edu/secsc/wp-content/uploads/GCMP_Tutorial_24Mar16.pdf) and an evaluation form to request evaluation from LCC coordinators and science coordinators. These were presented at two webinars in April 2016, and feedback was solicited during the webinar and afterwards by completion of the evaluation form, and follow-up by email and phone.

Populate the GCMP. In some cases, contact with a monitoring program representative resulted in program and site metadata offered for inclusion in the GCMP. More often, our procedures included drafting initial metadata for a program using available online or other information resources and sending it for review by program representatives along with a request for specific monitoring site locational information. Excel templates for collecting and formatting metadata for monitoring programs and for monitoring sites are shown as Attachments 1 and 2. In some instances, program entries were entered in the database, then sent for review. Some program and especially site information was harvested directly from large data warehouses such as Forest Inventory and Assessment, National Water Information System, STORET, and other data portals, or we encouraged program representative to provide it in an accessible format, then modified it to fit the site metadata template for batch upload to the GCMP. Program information is added to the metadatabase using web-based entry.

Using an evolving list of monitoring programs that now numbers more than 450 programs, we gathered and sought program metadata and site information, and populated the database with entries as information was developed and reviewed. At the end of this phase of the project, information for

205 programs has been included in the metadatabase along with metadata for 271,500 associated measurement sites. When it was not possible to obtain information about specific monitoring locations, measurement locations for a monitoring programs were represented by the centroid of state(s) in which it was determined that they make observations. We also continued to identify other observational networks for potential inclusion.

7. ANALYSIS AND FINDINGS:

The Global Change Monitoring Portal incorporates and represents the wide range of monitoring programs and observational networks that collect data relevant to the effects of global change processes, such as climate and land use change, on important air, land, and water resources in the Southeast. Of the 205 included in the GCMP, 52 make measurements in air, 89 on land, and 106 in water; many programs make observations in multiple media, so individual media measurements exceed the total. 92 programs make biological measurements, 85 make chemical measurements, and 159 make physical measurements. The number of monitoring locations for monitoring programs in the GCMP varied from 1 site up to 172,178 locations for USGS Water Resources of the United States - Ground Water. For 45 programs, state centroids were used to represent monitoring locations, so their number of sites aren't represented fully. Periods of record of monitoring programs span centuries in some cases – beginning before 1800 and continuing to present in the example of USGS Water Resources of the United States – Peak Flow. Many of the programs are still in operation, though the last record of measurement ranged from 1987 to 2016. Although this database and user interface allow a user to identify and connect to a considerable number of data resources in innovative ways, we recognize that this is a partial inventory of the monitoring programs in the footprint of the GCMP. Our draft compilation of programs includes twice the number already in the database. The GCMP can continue to provide information and exploration of the current static inventory of observational networks. The potential is there to add to or further develop the database and user interface with additional programs or features, or to integrate with other efforts.

8. CONCLUSIONS AND RECOMMENDATIONS:

Design of the relational database storing monitoring program and site metadata did not maintain multiple relationships among Media Type (Air, Land, Water) and Measurement Type (Biological, Chemical, Physical). When necessary, we divided program entries into components by Media Type in order to enable accurate results for searches for data of a specific Measurement Type in a particular Media Type. Incorporation of these parameter relationships into the database structure would simplify data entry into the portal and potentially streamline the web interface.

In the case of large data warehouses, development of metadata harvesting procedures to automate deriving metadata from their data repositories and conversion into the format required for entry in the GCMP would be a very useful component for metadata processing. This would not be practical for smaller data sources. Methods to take advantage of web services being developed by many programs in order to make their data accessible might be profitable. It has been suggested that creating a work flow that allows monitoring program representatives to enter metadata directly into the GCMP would encourage and enable more input of information, but given the challenges to directly gather data to this point, it's doubtful that would be worth the development effort.

The purpose of our request for evaluation of the GCMP in early 2016 was to inform potential options for the database, including those below:

- 1) Stop at current phase, add as layer to DataBasin, e.g., or another host platform
- 2) Continue updating program and site information in GCMP, for example:
 - a) Expand and refine list of monitoring programs/observational networks to include in GCMP
 - b) Populate database with information for additional programs and associated sites (~200 in current list)
 - c) Do periodic updates to existing program/site metadata
- 3) Consider additional development based on user needs
 - a) Develop additional capabilities or operationalize some aspects, such as:
 - Include search for period of record; enhance search capabilities, e.g. tag search; incorporate web services for updates to sites and last measurement dates; incorporate efficiencies in database and mapping functions
 - b) Consolidate effort with other inventorying activities in USGS or other organizations
 - c) Expand to other regions

There seem to be three options for the GCMP going forward:

1) *Status Quo*. To maintain the current status of the GCMP, an estimate of \$5100 annually in hosting and maintenance costs for the USGS Core Science Application Hosting Center is required. Doing periodic updates to the program/site metadata currently in the GCMP would require additional personnel resources.

Ideas for additional development have been tentatively discussed with the development team at USGS, such as developing APIs to feed metadata directly into the GCMP (mid-level effort) or creating an enterprise-level database (large-level effort), without specific detail of costs since that would be determined by the scope of effort required.

2) *Tailored SECAS Monitoring Tool*. During discussions and evaluation of the GCMP in April, one recommendation was to consider developing a sub-tool that would be tailored to an initiative like the Southeast Conservation Adaptation Strategy. In contrast to enlarging the information in the GCMP, the sub-tool would focus on a more limited set of monitoring data identified by SECAS as important monitoring information to assess changes in ecosystems, or to monitor progress towards conservation objectives. Attempts to identify support for this effort have not yet been successful.

3) *Archive*. Not actively maintaining the database functions, mapping, and web interface will result in the GCMP becoming out-of-date and potentially non-functional, so the GCMP would be removed as an active tool for the SE CSC community.

9. MANAGEMENT APPLICATIONS AND PRODUCTS:

We expect that the Global Change Monitoring Portal will be used by individuals in various capacities and organizations to identify specific biotic and abiotic data resources collected in aquatic and terrestrial ecosystems in a particular geographic area of interest. The GCMP could especially be utilized in evaluating regional changes in ecosystems resulting from changes in climate and land use and in developing and monitoring landscape-level conservation strategies.

We worked with many land managers, administrators, and decision makers, as well as field personnel and data managers, to solicit input during the project, for the following purposes: a) recommend specific data platforms and capabilities for the GCMP design; b) identify/recommend appropriate observational networks to include in the GCMP; c) identify best contacts for specific monitoring

programs; d) provide information and details about specific monitoring programs and measurement locations; e) evaluate features and functions of the GCMP.

10. OUTREACH:

Global Change Monitoring Portal URL: <https://my.usgs.gov/gcmp>.

Project website on Southeast Climate Science Center website:

<https://globalchange.ncsu.edu/secsc/resources/southeast-global-change-monitoring-portal/>

Seminar Presentation: Development of a Global Change Monitoring Portal: Pilot Project for the Southeastern US, Cari S. Furiness, Triangle Climate and Landscape Researchers' Brown Bag, 11/13/2014.

Tutorial for Global Change Monitoring Portal: https://globalchange.ncsu.edu/secsc/wp-content/uploads/GCMP_Tutorial_24Mar16.pdf

Southeast Global Change Monitoring Portal, demonstration at Tools Café, Southeast and Caribbean Climate Community of Practice 2016 meeting: Building Adaptive Capacity in the Southeast & Caribbean through a Climate Community of Practice. April 13-15, 2016, Tybee Island, GA. One-page fact sheet on the GCMP was also developed for the meeting.

Southeast Climate Science Center Webinar Presentations: Global Change Monitoring Portal: Features and Functions, Cari S. Furiness, 4/21/16 and 4/29/16.

Project results have been communicated on an ongoing basis in conversations with partners and especially program representatives when soliciting information about observational networks and measurement sites.

Attachment 1. Global Change Monitoring Portal Program Information Template. *Guidance for completing information about an observational network/ monitoring program for inclusion in the SE Global Change Monitoring.*

Column	Description	Format/Data Entry Rules
Program	Name of observational network/ monitoring program or project.	Can be part of larger program.
Acronym	Short acronym for program	Will be assigned if not provided and may be changed if necessary.
Program Description	General description of observational network/ monitoring program	Include some detail of specific types of measurements made.
Program URL	URL of website with information about the observational network/ monitoring program	If no URL available, default will be my.usgs.gov/GCMP
Management Issue Addressed / Purpose of Sampling	Phrases describing the management issue(s) the monitoring program is designed to address or purpose(s) for which observations are made	No required values. Multiple values allowed; separate with " "
Operational Status	Indication of whether monitoring program is still making measurements.	Acceptable values are Active OR Inactive.
Sponsoring Organization(s) Name	Name(s) of organization(s) that provide(s) primary support for the observational network	Multiple values are allowed; separate with ", ". If acronym used, please provide definition.
Sponsoring Organization Type	Type(s) of organization(s) that provide(s) primary support for the observational network	No required values. Examples: Federal, State, Tribal, Regional, Academia, NGO. Multiple values allowed; separate with ", ".
Media Type	Abiotic component of the environment in which a measurement is made (Air, Land, Water)	Acceptable values are Air; Land; Water. Multiple values allowed; separate with "; ". If more than one Media Type AND more than one Measurement Type are sampled, each Media Type should be listed in a separate row.
Measurement Type	Category of ecosystem property measured (Biological, Chemical, Physical)	Acceptable values are Biological; Chemical; Physical. Multiple values allowed; separate with "; ". If more than one Media Type AND more than one Measurement Type are sampled, each

		Media Type should be listed in a separate row.
Biological Parameter Type	Type of biological parameter measured (Ecosystem, Fauna, Flora, Other Biological). Other Biological may include: Bacteria, Fungi, Algae. Ecosystem may include: measures of biodiversity and productivity, multi-species community type.	Acceptable values are Ecosystem; Fauna; Flora; Other Biological. Multiple values are allowed; separate with "; ".
Chemical Parameter Type	Type of chemical parameter measured (Metals, Nutrients, Organic, Other Chemical). Other Chemical may include: inorganic chemical species; measurements such as pH, alkalinity, salinity, chlorophyll-a; chemical constituents such as toxics, dissolved organic carbon, total organic carbon; stable isotopes.	Acceptable values are Metals; Nutrients; Organic; Other Chemical. Multiple values are allowed; separate with "; ".
Physical Parameter Type	Type of physical parameter measured (Habitat, Hydrologic, Land cover, Meteorological, Other Physical, Soil/Sediment, Surface elevation). Hydrologic may include: measures of flow and level; field parameters such as temperature, pH, specific conductance, total hardness, dissolved oxygen; physical properties such as light attenuation, turbidity. Other Physical may include: geomorphology, topography.	Acceptable values are Habitat; Hydrologic; Land cover; Meteorological; Other Physical; Soil/Sediment; Surface elevation. Multiple values allowed; separate with "; ".
Sampling Frequency	Phrase describing how often measurements are made	No required values. Examples: Monthly, Every 2 years, Continuous, Various.
Number of Stations	Number of sites at which measurements are made	This may be different than the number of sites in the GCMP region of interest. Can be approximate.
Data Span - Start	Date when program began making measurements	MM/DD/YYYY or YYYY
Data Span - End	Date when program ceased making measurements	MM/DD/YYYY or YYYY. Leave blank if ongoing.
Area Sampled	General description of the area sampled by the observational network/ monitoring program	May be different than GCMP region of interest.

Program Contact Name	Name of primary contact for information about observational network/ monitoring program	First Last. Leave blank if not available.
Program Contact Email	Email address of primary contact for information about observational network/ monitoring program	Leave blank if not available.
Data Access URL	URL of website where data collected by observational network/ monitoring program may be accessed	Not required. Default may be Program URL.

Attachment 2. Global Change Monitoring Portal Monitoring Site Information Request Form. *Guidance, including required formatting, for completing information about a monitoring station or site for inclusion in the SE Global Change Monitoring Portal.*

Column	Description	Format/Data Entry Rules
Program	Name of observational network/ monitoring program under which the site or station is operated	Required. must match name in Program Information sheet.
Acronym	Short acronym for program	Not required. Will be derived from Program Information sheet.
Site Code	Code or short name used as the site or station identifier within the monitoring program	Required. Does not have to be unique.
Site Name	Full name of the site or station	Required. Does not have to be unique. Can be duplicative of Site Code, or descriptive.
Description	Descriptive information for the site or station, e.g. local geographic features, station type	Not required.
Latitude (WGS84)	Geographic latitude in decimal degrees using WGS84 or NAD83 Geographic Coordinate System, which are assumed to be functionally equivalent in our mapping	Required. Please provide using WGS84 if possible. If coordinates do not use WGS84 Geographic Coordinate System, please indicate GCS used in XY Datum column.
Longitude (WGS84)	Geographic longitude in decimal degrees using WGS84 or NAD83 Geographic Coordinate System, which are assumed to be functionally equivalent in our mapping	Required. Please provide using WGS84 if possible. If coordinates do not use WGS84 Geographic Coordinate System, please indicate GCS used in XY Datum column.
Proximity	Descriptor for how close the geographic coordinates are to the actual sampling location. Examples include: Exact – Exact sampling location; Approximate – Approximate sampling location; Offset – Offset to exact sampling location; Start – Beginning point of a linear sampling location; Boundary – One of a set of points used to describe the boundary of a polygon sampling location; Center – Center of polygon containing sampling location(s); Admin – Administrative center of site or facility containing sampling location; Other – Coordinates represent a scenario not listed; Unknown – Relationship between the coordinates given and the sampling location is	Required. Acceptable values are: Exact; Approximate; Offset; Start; Boundary; Center; Other; Unknown; Not Reported.

	unknown; Not Reported – Information is not reported regarding the relationship between the coordinates given and the sampling location.	
State	Geographic assignment based on geographic coordinates	Leave blank. This will be derived from GIS mapping software.
HUC8	Geographic assignment based on geographic coordinates	Leave blank. This will be derived from GIS mapping software.
LCC	Geographic assignment based on geographic coordinates	Leave blank. This will be derived from GIS mapping software.
Ecoregion	Geographic assignment based on geographic coordinates	Leave blank. This will be derived from GIS mapping software.
Date Start	Date the monitoring activity started at monitoring station or site; date of first observation	Required. MM/DD/YYYY or YYYY. If date resolution is to month, use MM/01/YYYY.
Date End	Date the monitoring activity ended at monitoring station or site if inactive, or date of last observation if active	Required. MM/DD/YYYY or YYYY. If date resolution is to month, use MM/01/YYYY.
Media Type	Abiotic component of the environment in which a measurement is made (Air, Land, Water)	Required. Information for this monitoring station can be the same or different from Program-level information. Acceptable values are Air; Land; Water. Multiple values allowed; separate with "; ". If more than one Media Type AND more than one Measurement Type are sampled, each Media Type should be listed in a separate row.
Measurement Type	Category of ecosystem property measured (Biological, Chemical, Physical)	Required. Information for this monitoring station can be the same or different from Program-level information. Acceptable values are Biological; Chemical; Physical. Multiple values allowed; separate with "; ". If more than one Media Type

		AND more than one Measurement Type are sampled, each Media Type should be listed in a separate row.
Biological Parameter Type	Type of biological parameter measured (Ecosystem, Fauna, Flora, Other Biological). Other Biological may include: Bacteria, Fungi, Algae. Ecosystem may include measures of biodiversity or productivity, multi-species community type.	Required. Information for this monitoring station can be the same or different from Program-level information. Acceptable values are Ecosystem; Fauna; Flora; Other Biological. Multiple values are allowed; separate with ";".
Chemical Parameter Type	Type of chemical parameter measured (Metals, Nutrients, Organic, Other Chemical). Other Chemical may include: inorganic chemical species; measurements such as pH, alkalinity, salinity, chlorophyll-a; chemical constituents such as toxics, dissolved organic carbon, total organic carbon; stable isotopes.	Required. Information for this monitoring station can be the same or different from Program-level information. Acceptable values are Metals; Nutrients; Organic; Other Chemical. Multiple values are allowed; separate with ";".
Physical Parameter Type	Type of physical parameter measured (Habitat, Hydrologic, Land cover, Meteorological, Other Physical, Soil/Sediment, Surface elevation). Hydrologic may include: measures of flow and level; field parameters such as temperature, pH, specific conductance, total hardness, dissolved oxygen; physical properties such as light attenuation, turbidity. Other Physical may include: geomorphology, topography.	Required. Information for this monitoring station can be the same or different from Program-level information. Acceptable values are Habitat; Hydrologic; Land cover; Meteorological; Other Physical; Soil/Sediment; Surface elevation. Multiple values allowed; separate with ";".
Website URL	URL of website with information about the observational network/ monitoring program	Leave blank. This will be derived from Program Information sheet.
Data URL	URL of website where data collected by observational network/ monitoring program may be accessed	Leave blank. This will be derived from Program Information sheet.
Last Update	Date that station information was most recently updated	MM/DD/YYYY. Date that station and measurement information was acquired.
XY Datum	Reference model representing a specific geodetic system for describing a point on the earth's surface	Not required unless Latitude and Longitude are not provided using WGS84 Geographic Coordinate System.